

NASA Collaborative Approach Mitigates Environmentally-Driven Obsolescence



DMSMS Conference

November 30, 2016

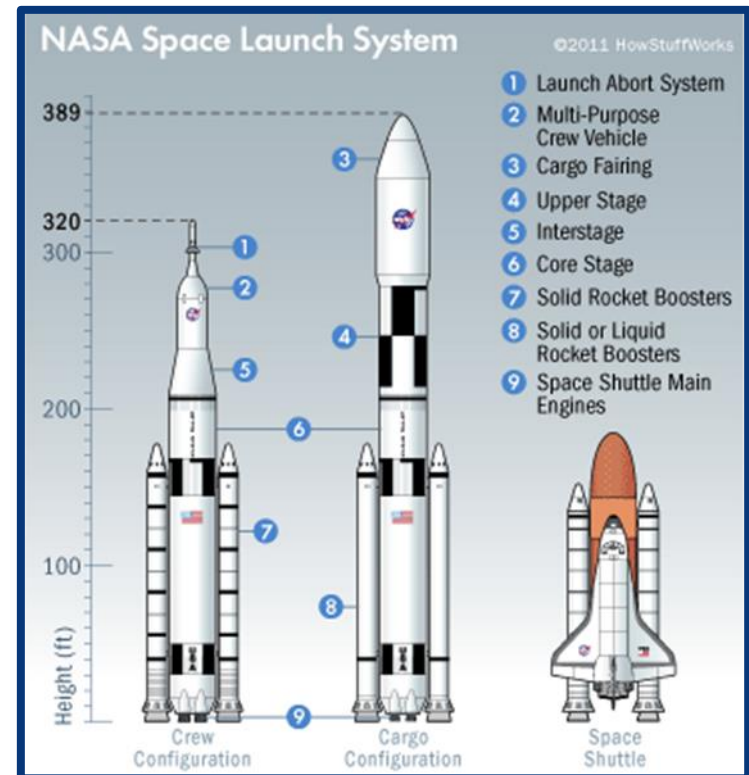
Brian Greene, ITB Inc., Kennedy Space Center, FL

Bob Leeney, ITB Inc., Merritt Island, FL

Joni Richards, NASA, Kennedy Space Center, FL

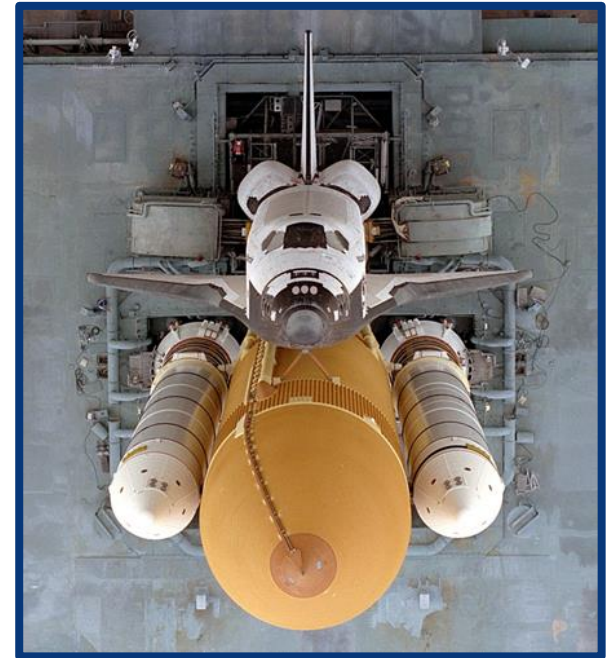
NASA's Environmentally-Driven Supply Chain Risks

- Focus on environmentally-driven risks
 - Increasing EH&S requirements
 - Material obsolescence and loss of critical materials
 - Risk for legacy systems, new programs and critical infrastructure
 - NASA requires rigorous testing and qualification of replacements



Space Shuttle Experience (1981-2011)

- Environmental regulations created material obsolescence risks
- Shuttle team identified and mitigated risks
- Stockpiled HCFC 141b
- Replaced and stockpiled TCA
- Hexavalent chromium replaced in some coating operations
- Electronic components stockpiled, batch tested to identify lead-free solder



Space Shuttle Experience (1981-2011)

Requirement/ Regulation	Material Affected	Shuttle Impacts
Protection of Stratospheric Ozone: Montreal Protocol; CAA	CFCs, Freon®, Halon, TCA, HCFC 141b	Precision cleaning, blowing agent, fire protection, thermal protection system
NESHAPS, CAA	Hazardous Air Pollutants	Surface cleaning, coatings and associated operations
Criteria Pollutant Regulations, CAA	VOCs	Surface cleaning, coatings, and associated operations
TSCA	Perfluorinated chemicals	Used in many applications, coatings, seals
Permissible Exposure Limits: OSHA	Hexavalent Chromium Cr(VI)	Operations to prevent corrosion of aluminum substrates
European Regulations: REACH	Heavy Metals, Brominated Flame Retardants, Leaded solders and electrical components	Coating systems, electrical components, other critical operations

Challenges for Current and New Programs

- NASA hardware (SLS) and infrastructure face continued regulatory pressure
- Montreal Protocol likely to be amended to include a phase-out of HFCs
- Hexavalent chromium and lead free electronics still present risk
- Under update to TSCA, EPA may implement more stringent requirements for a number of substances
- European Union REACH will continue to evaluate and restrict use of widely used chemicals



Core Stage Liquid Hydrogen tank for the Space Launch System

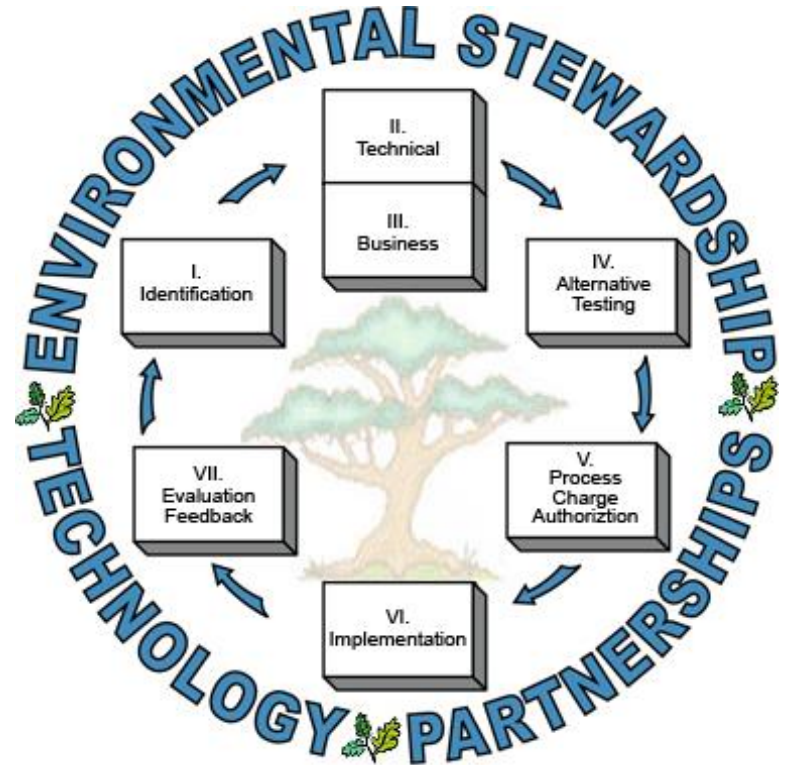
NASA TEERM

- NASA Technology Evaluation for Environmental Risk Mitigation (TEERM) Principal Center, located at Kennedy Space Center
- Tracks environmental regulations
- Evaluates potential impacts
- Identifies and evaluates viable technological solutions
- Works to get solutions implemented
- TEERM Project Process:
 - Solutions that reduce environmentally-driven risk
 - Partnerships/Collaboration
 - Comprehensive test planning
 - Leveraging resources

Comprehensive Test Planning

TEERM takes opportunities from concept through project execution:

- Target the need
- Identify and assess alternatives
- Identify technical requirements
- Prepare test plan
- Identify total project resources
- Proceed with project



Partnerships/Collaboration

- Benefits include:
 - Reduces cost burden on any one team member
 - Enhances technical quality
 - Can speed implementation
- Partner include:
 - NASA Centers
 - European Space Agency
 - Industry contractors
 - U.S. Dept. of Defense



TEERM PROJECT (Completed): Flight Testing of Non-Chromated Primers

- Regulations threaten supply chain for coatings containing CrVI
- Down-selection and demonstration/validation of non-chromate primers
- Multi-agency project, sponsored by ESTCP
- Testing aboard a NASA P-3 aircraft
- Parallel testing & evaluation at KSC
- Innovative features: corrosion inhibiting makeup
- First to test the newest iterations of these innovative materials



NASA P-3 Orion aircraft and one of the coated sample test panels (insert) used for the aircraft field demonstration

TEERM PROJECT (Active): NASA-ESA Hexavalent Chromium Free Coatings

- Testing coatings/coating systems in aerospace applications
- Initial project supported by NAVAIR and NASA GSDO
- Ongoing project with the European Space Agency
- Addresses requirements for multiple stakeholders
- Direct and in-kind support from participants
- Innovation: coatings uniquely available in Europe



Hexavalent Chrome Free coatings research, supported by NAVAIR and GSDO with follow-on parallel testing with ESA

TEERM PROJECT (Completed):

Lead Free Electronics

- European regulations restrict use of lead
- Lead-free solder becoming the norm for commercial use
- Concerns: tin whiskers, high-reliability applications
- NASA Parts Policy requires use of tin-lead solders
- Goddard Space Center, NASA Electronic Parts Assurance Group
- Working collaborative projects since 2001
- Study on tin whiskers



TEERM PROJECT (Planned):

Lead Free Solder

- Reliability of most lead-free solders not well known
- Reliability testing of circuit cards
 - Newly manufactured and reworked with lead-free solder
 - Subjected to simulated high-reliability conditions
- Planning a study with lower process temperatures during assembly



Future Plans and Challenges

➤ Challenges

- Expect continuous regulatory pressure
- Obsolescence risks
- Move to commercial space flight
- Obsolescence not always a priority

➤ TEERM Plans

- Continue emphasis on risk assessment
- Continue communication
- Develop projects that mitigate infrastructure and hardware risks
- Involve additional partners to leverage resources



Summary

- NASA Programs face environmentally-driven materials obsolescence risks
- TEERM identifies risks that can impact the NASA mission
- TEERM identifies and evaluates viable technological solutions
- TEERM's collaborative approach:
 - reduces the cost burden on any one team partner,
 - reduces duplication of effort, and
 - enhances the technical quality and overall applicability of the testing and analysis

NASA TEERM Principal Center Questions?



For more information visit the
NASA TEERM Website:

[*www.teerm.nasa.gov*](http://www.teerm.nasa.gov)